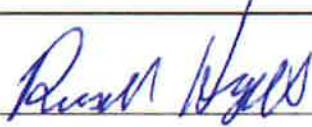






CALCULATION PACKAGE COVER SHEET

Client: Gowanus Canal Remedial Design Group (RD Group) **Project:** Gowanus Canal Superfund Site **Project #:** HPH106A

TITLE OF PACKAGE: _____ **TYPES AND QUANTITIES OF TREATMENT ADDITIVES**

PREPARATION	CALCULATION PREPARED BY: (Calculation Preparer, CP)	Signature <u></u>	<u>5/19/17</u>
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REVISION HISTORY:

NO.	DESCRIPTION	DATE	CP	APC	CC	CA
0	TB4 Pilot Study Design – Issued for Bid	05/19/2017	RH	JJB	JJB	JFB

							Page	1	of	13	
CP:	<u>RH</u>	Date:	<u>05/19/17</u>	APC:	<u>JJB</u>	Date:	<u>05/19/17</u>	CC:	<u>JJB</u>	Date:	<u>05/19/17</u>
Client:	<u>RD Group</u>	Project:	<u>Gowanus Canal Superfund Site</u>					Project No:	<u>HPH106A</u>		

TYPES AND QUANTITIES OF TREATMENT ADDITIVES

INTRODUCTION AND PURPOSE

The dredged material to be removed from the 4th Street Turning Basin (TB4) will be comprised primarily of overlying recently deposited soft sediment with a lesser volume of native alluvial and glacial deposits. According to the EPA Feasibility Study (FS), reactivity, pH, ignitability, and toxicity characteristic leaching procedure (TCLP) data indicate that untreated sediment from the Gowanus Canal (Canal) would not be considered as a characteristic hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Further testing performed as part of the PD-10/21 Treatability Study also indicates that Canal sediment can be managed as a nonhazardous waste.

The potential options for managing nonhazardous waste include beneficial use such as placement as daily cover at a landfill or disposal at a RCRA Subtitle D landfill. Both options would require further treatment of the dredged material to meet site-specific acceptance criteria. Consistent with the ROD, sediment treatment and disposal methods are anticipated to vary based on the reach and contaminant levels. Excluding areas of the Canal with elevated PCB and lead concentrations, the ROD prescribes end-placement of dredged material for beneficial use such as daily landfill cover. Based on historic sediment data, dredged material from TB4 is not anticipated to contain elevated concentrations of PCB or lead. Therefore, dredged material removed during the TB4 Pilot Study is anticipated to be placed at a beneficial use end-placement facility. Dredged material must meet the physical and chemical acceptance criteria of the beneficial use end-placement facility. Beneficial use end-placement acceptance criteria have been compiled as part of the addendum to the PD-10/21 Report. In order to meet the beneficial use end-placement criteria dredged material from TB4 will first be processed via stabilization/solidification (S/S). This calculation package details the type of S/S reagent selected for treatment of dredged sediment from TB4 and recommends a dosage of S/S reagent based on feedback from end-placement facilities and the results of the PD-10/21 Treatability Study.

DESIGN CRITERIA AND MAJOR ASSUMPTIONS

Results from the PD-10/21 Treatability Study, the addendum to the PD-10/21 Treatability Study Report, the Geotechnical Properties of Treated Sediment Calculation Package, and the Results from Leachability Testing Calculation Package have been used to determine the anticipated type and dosage of S/S reagent for the TB4 Pilot Study.

CP: **RH** Date: **05/19/17** APC: **JJB** Date: **05/19/17** CC: **JJB** Date: **05/19/17**
Client: **RD Group** Project: **Gowanus Canal Superfund Site** Project No: **HPH106A**

For the purposes of this calculation package, it is assumed that Portland cement will be used as the S/S reagent. As indicated in the PD-10/21 Treatability Study Report, Portland cement is a common and readily available additive routinely used for treatment of dredged sediment. As such, Portland cement was used during the PD-10/21 Treatability Study to stabilize/solidify dredged material at 8%, 12%, and 15% by wet weight. Feedback from beneficial use end-placement facilities have indicated that processed dredged material (PDM) amended with Portland cement from the Gowanus Canal would potentially be acceptable in their facilities based on the data provided from the PD-10/21 Treatability Study with Portland cement used as the S/S reagent. Furthermore, Portland cement was used successfully during the debris removal phase of the TB4 Pilot Study to stabilize/solidify dredged material removed during debris field removal to pass Paint Filter Liquid Test (EPA SW-846 Method 9095A) requirements for transportation off-site via truck. Although Portland cement has been proven effective at stabilizing/solidifying dredged material from the Gowanus Canal, the Contractor will be permitted to suggest alternative treatment additives during the bid process based on Contractor experience.

The critical design criterium for treated dredged material is that the material must meet the acceptance criteria of the beneficial use end-placement facility. As indicated in the addendum to the PD-10/21 Treatability Study Report, feedback from end-placement facilities indicates that several facilities would potentially accept for use as daily cover S/S treated dredged material from the Gowanus Canal. End-placement facilities indicated that the chemical characteristics of the material were more important than the physical characteristics to determine acceptability for use as daily cover. Physically, the material needs to be readily gradable. Therefore, based on the Results of Leachability Testing Calculation Package and discussions with end-placement facilities, the recommended dosage of Portland cement for planning purposes during the TB4 Pilot Study is 12 percent. A lower dosage of Portland cement was used during the debris removal pilot test. However, this dosage was applied to dredged material to pass Paint Filter Test requirements for transport. A higher dosage will be required for beneficial use end-placement.

The major assumptions for estimating the type and quantity of treatment additive are as follows:

- The sediments within TB4 are not a characteristic hazardous waste based on the data provided in Table I-20 of the FS and the results of the PD-10/21 Treatability Study.
- The FS and ROD do not identify any potential listed waste
- As identified in the ROD, some areas of the Canal may contain concentrations of PCBs and lead that may preclude some treatment and beneficial use options. Sediments from these areas will be managed separately in accordance with the appropriate regulations.

CP: **RH** Date: **05/19/17** APC: **JJB** Date: **05/19/17** CC: **JJB** Date: **05/19/17**
Client: **RD Group** Project: **Gowanus Canal Superfund Site** Project No: **HPH106A**

Dredged material removed during the TB4 Pilot Study will not contain PCB and lead concentrations that would result in the need to manage the material separately.

- S/S treated dredged material from TB4 that fails to meet the acceptance criteria of the beneficial use end-placement facility will be accepted at a thermal treatment facility and thermally treated as indicated in the Thermal Desorption Acceptability Evaluation Calculation Package. Once thermally treated, the PDM will meet the end-placement acceptance criteria.
- Sediment samples collected for the PD-10/21 Treatability Study exhibit similar moisture contents than can be expected during dredging. Samples were collected from cores, homogenized, and placed in buckets prior to mixing with Portland cement. Any observed free water that separated out between placing the sediment in buckets and mixing with Portland cement was mixed in with the Portland cement. During full-scale operations, most of the excess dredge water will be pumped off prior to addition of Portland cement. However, some small volume of excess dredge water will remain due to limitations with the pumping equipment. This small volume of excess dredge water will be mixed in with the Portland cement. Therefore, the sample handling preparation during the PD-10/21 Treatability Study are considered representative of full-scale operations.

METHODOLOGY

Quantities of Portland cement additive are based on the estimated volume of material to be dredged during the TB4 Pilot Study. The estimated volume of material to be dredged during the TB4 Pilot Study was obtained from The TB4 Dredge Volume Calculation Package and is provided in Table 1 of this calculation package. These volumes were broken down by dredging phase: Access Channel Dredging, Phase I – Dredging of Soft Sediment, Phase II – Dredging of Targeted Alluvial Removal Areas (TNARA), and Phase III – Dredging of Sediments beneath the 3rd Avenue Bridge. Portland cement will be added on a wet weight basis. This is common practice for dredging projects due to the relative ease of estimating weight on a wet weight basis during implementation compared to a dry weight basis. Since these calculations are based on wet weights, the moisture content of the sediment is already accounted for in the total weight of the sediment. Calculations to estimate the quantity of Portland cement have been performed assuming an 8, 12, and 15 percent dosage on a wet weight basis consistent with the dosages tested during the PD-10/21 Treatability Study.

In order to estimate the weight of dredged material to be amended, volume estimates obtained from the TB4 Dredge Volume Calculation Package were converted to weight estimates. These weight

CP: **RH** Date: **05/19/17** APC: **JJB** Date: **05/19/17** CC: **JJB** Date: **05/19/17**

Client: **RD Group** Project: **Gowanus Canal Superfund Site** Project No: **HPH106A**

estimates account for the weight of soft sediment, native alluvial sediment, and glacial deposits anticipated to be dredged during the TB4 Pilot Study.

The three general stratigraphic layers in TB4, listed in descending order from the top to the bottom, are described as follows:

- (i) **Soft Sediment:** Material consists of organics, organic silts and clays with varying components of sand, silty sand, gravel and debris/trash. Color ranges from grey to black and dark brown to black. Density ranges from very soft to soft.
- (ii) **Native Alluvial Sediment:** Material consists of marsh deposits (denser than Soft Sediment), mixture of elastic silt, sandy silt, sand and clay, with fibrous roots and vegetation/wood debris. Color ranges from reddish brown to dark gray to black. Density ranges from very soft to stiff/medium dense.
- (iii) **Glacial Deposits:** Material consists of gravelly sand, poorly and well graded sand, fine to coarse grained sand and small to large sub-angular gravel, with varying amounts of silt and silty sand, with some clay (sometimes interbedded to laminated). Color ranges from tan to brown to gray to dark gray and reddish brown. Density ranges from very loose to very dense, densifying with depth.

As can be expected, the total unit weights (defined as the wet weight of the material per volume of material) of each of the stratigraphic layers vary with the soft sediment having the lowest unit weight and the glacial deposits having the highest unit weight. Unit weights were obtained from the Summary of Geotechnical Design Parameters Calculation Package included in the RTA1 35% design report. These weights are provided in this calculation package as Table 2. These total unit weights are based on laboratory measurements of total unit weights measured from sediment samples collected from all reaches of the Canal. These average total unit weights were used for this calculation rather than total unit weights specific to samples collected from TB4 during the PD-10/21 Treatability Study in order to account for the likely variability of measured total unit weight among sediment samples. For instance, the sample of native material from the PD-10/21 Treatability Study consisted of a gray clay which is likely not consistent with the physical characteristics of the native material to be dredged during the TB4 Pilot Study.

Calculation of the Quantity of Portland Cement Required

An estimation of the weight of Portland cement to be amended can be acquired by estimating the weight of dredged material and multiplying by the dosage of Portland cement as follows:

CP: **RH** Date: **05/19/17** APC: **JJB** Date: **05/19/17** CC: **JJB** Date: **05/19/17**

Client: **RD Group** Project: **Gowanus Canal Superfund Site** Project No: **HPH106A**

$$W_{PC} = W_{dredged} \times \% \text{ Portland cement} / 100\% \quad (1)$$

Where:

W_{PC} = The total weight of Portland cement, tons

$W_{dredged}$ = The weight of dredged material on a wet weight basis, tons

% Portland cement = The dosage of Portland cement on a wet weight basis, %

An estimation of the weight of dredged material can be obtained from the anticipated volume to be dredged of soft sediment, native alluvial sediment, and glacial deposits using the total unit weights of the soft sediment, native alluvial sediment, and glacial deposits as follows:

$$W_{dredged} = V_{soft} \times \gamma_{soft} + V_{alluvial} \times \gamma_{alluvial} + V_{glacial} \times \gamma_{glacial} \quad (2)$$

Where:

$W_{dredged}$ = The total weight dredged, tons

V_{soft} = Estimated volume of soft sediment to be dredged, CY

γ_{soft} = Total unit weight of soft sediment, tons/CY

$V_{alluvial}$ = Estimated volume of native alluvial sediment to be dredged, CY

$\gamma_{alluvial}$ = Total unit weight of native alluvial sediment, tons/CY

$V_{glacial}$ = Estimated volume of glacial deposits to be dredged, tons/CY

$\gamma_{glacial}$ = Total unit weight of glacial deposits, tons/CY

Combining equation (1) and equation (2) an estimate of the quantity of Portland cement required to treat the estimated volume of dredged material can be obtained as follows:

CP: **RH** Date: **05/19/17** APC: **JJB** Date: **05/19/17** CC: **JJB** Date: **05/19/17**
Client: **RD Group** Project: **Gowanus Canal Superfund Site** Project No: **HPH106A**

$$W_{PC} = (V_{soft} \times \gamma_{soft} + V_{alluvial} \times \gamma_{alluvial} + V_{glacial} \times \gamma_{glacial}) \times \%Portland\ cement / 100\% \quad (3)$$

COMPUTATIONS AND RESULTS

Spreadsheet computations are provided in Tables 3. The quantity of Portland cement was estimated assuming a dosage of 8%, 12%, and 15%. With a recommended dosage of 12% Portland cement, a total of approximately 3,013 tons of Portland cement is required.

A manual (i.e., hand) calculation was performed to verify the spreadsheet computations. The manual calculation was completed for access channel dredging assuming a dosage of 12% Portland cement and is provided as Attachment A.

SUMMARY AND CONCLUSIONS

Estimates of the quantity of Portland cement required to amend the anticipated volume of dredged material from TB4 was calculated assuming an 8, 12, and 15 percent dosage of Portland cement. Portland cement was selected as the treatment additive due to its proven ability and widespread use in the dredged material treatment and disposal industry. A 12 percent dosage is recommended based on the results of the PD-10/21 Report, addendum to the PD-10/21 Report, and sediment treatment calculation packages. With a recommended dosage of 12 percent Portland cement, a total of approximately 3,013 tons of Portland cement is required.

This estimate serves to provide an understanding of the approximate quantity of Portland cement needed to treat the dredged material satisfactory to the end-placement facility acceptance criteria. Two methods of mixing will be tested during the TB4 Pilot Study. Portland cement will be mixed with dredged material on-site via in-barge mixing or off-site at a commercial sediment processing facility. There are several concrete facilities along the Gowanus Canal, and therefore, it is anticipated that sources of Portland cement are available. It will be the responsibility of the Contractor to ensure that the supply of reagent meets dredge production rates. In practice, depending on the contents of individual barge loads of dredged material, dredged material may require more or less Portland cement in order to display the appropriate strength and chemical characteristics. For instance, some barge loads of dredged material may exhibit higher moisture contents than the moisture contents of the sediment samples used for the PD-10/21 Treatability Study. In this circumstance, additional Portland cement may be required than predicted to obtain similar characteristics of the material. These types of adjustments to the dosage of Portland cement are to be expected during implementation.

CP: **RH** Date: **05/19/17** APC: **JJB** Date: **05/19/17** CC: **JJB** Date: **05/19/17**

Client: **RD Group** Project: **Gowanus Canal Superfund Site** Project No: **HPH106A**

REFERENCES

CH2M Hill, December 2011. “Draft Feasibility Study, Gowanus Canal.”

Geosyntec (2016). “PD-10/21 Dredged Material Stabilization and Dewatering Treatability Study Report”, Prepared by Geosyntec Consultants, Inc. and Beech and Bonaparte Engineering, P.C., August 2016 (Draft).

Geosyntec (2017). “Thermal Treatment and Beneficial Use End-Placement Acceptability Evaluation”, Prepared by Geosyntec Consultants, Inc. and Beech and Bonaparte Engineering, P.C., February 2017.

United States Environmental Protection Agency (EPA), September 2013. “Record of Decision, Gowanus Canal Superfund Site, Brooklyn, King County, New York.”

CP: **RH** Date: **05/19/17** APC: **JJB** Date: **05/19/17** CC: **JJB** Date: **05/19/17**

Client: **RD Group** Project: **Gowanus Canal Superfund Site** Project No: **HPH106A**

TABLES

CP: **RH** Date: **05/19/17** APC: **JJB** Date: **05/19/17** CC: **JJB** Date: **05/19/17**
Client: **RD Group** Project: **Gowanus Canal Superfund Site** Project No: **HPH106A**

Table 1. Summary of Dredge Volumes by Dredge Phase and Material Type

Description	Access Channel	Phase I	Phase II	Phase III	Total
Soft Sediment (CY)	2778	15980	0	453	19211
Native Alluvial (CY)	0	0	2629	0	2629
Glacial Deposits (CY)	0	0	166	0	166
Total Dredge Volume (CY)	2778	15980	2795	453	22006

Notes:

1. The estimated volume of material to be dredged during each phase was obtained from The TB4 Dredge Volume Calculation Package.
2. The volume of glacial deposits to be treated during Phase II was computed using AutoCAD Civil3D composite volume method as detailed in the TB4 Dredge Volume Calculation Package.

CP: **RH** Date: **05/19/17** APC: **JJB** Date: **05/19/17** CC: **JJB** Date: **05/19/17**
Client: **RD Group** Project: **Gowanus Canal Superfund Site** Project No: **HPH106A**

Table 2. Total Unit Weight by Material Type

Soil Unit	Total Unit Weight (pcf)	Total Unit Weight (tons/CY)
Soft Sediment	80	1.08
Native Alluvial Sediment	115	1.55
Glacial Deposit	125	1.69

Notes:

1. The total unit weights of each soil unit was obtained from Table 9 of the Summary of Geotechnical Design Parameters Calculation Package included in the RTA1 35% design report.

CP: **RH** Date: **05/19/17** APC: **JJB** Date: **05/19/17** CC: **JJB** Date: **05/19/17**

Client: **RD Group** Project: **Gowanus Canal Superfund Site** Project No: **HPH106A**

Table 3. Estimated Weights of Portland Cement

Description	Access Channel	Phase I	Phase II	Phase III	Total
Weight of Soft Sediment (tons)	3000	17258	0	489	20748
Weight of Alluvial Sediment (tons)	0	0	4082	0	4082
Weight of Glacial Deposits (tons)	0	0	280	0	280
Total Weight of Dredged Material (tons)	3000	17258	4362	489	25110
Weight of Portland Cement at 8% Dosage (tons)	240	1381	349	39	2009
Weight of Portland Cement at 12% Dosage (tons)	360	2071	523	59	3013
Weight of Portland Cement at 15% Dosage (tons)	450	2589	654	73	3766

Notes:

1. These quantities are estimated based on dredge volumes obtained from the TB4 Dredge Volume Calculation Package.

CP: **RH** Date: **05/19/17** APC: **JJB** Date: **05/19/17** CC: **JJB** Date: **05/19/17**

Client: **RD Group** Project: **Gowanus Canal Superfund Site** Project No: **HPH106A**

ATTACHMENT A
MANUAL CALCULATION AND SPREADSHEET VERIFICATION

Example Calculation for Access Channel Dredging, 12% Portland Cement

General Inputs:

Volume of soft sediment to be dredged: 2778 CY

Volume of native alluvial to be dredged: 0 CY

Volume of glacial deposits to be dredged: 0 CY

Total unit weight of soft sediment: 1.08 tons/CY

Calculation:

$$\begin{aligned}
 W_{PC} &= \left(V_{\text{soft}} \gamma_{\text{soft}} + V_{\text{alluvial}} \gamma_{\text{alluvial}} + V_{\text{glacial}} \gamma_{\text{glacial}} \right) \times \frac{\% \text{ Portland Cement}}{100\%} \\
 &= \left[(2778 \text{ CY})(1.08 \text{ tons/CY}) + (0 \text{ CY}) \cancel{\gamma_{\text{alluvial}}} + (0 \text{ CY}) \cancel{\gamma_{\text{glacial}}} \right] \left(\frac{12\%}{100\%} \right) \\
 &= (3000.24 \text{ CY} \cdot \frac{\text{tons}}{\text{CY}})(0.12)
 \end{aligned}$$

$$W_{PC} = 360. \text{ ton}$$